

## APPENDIX D

### WEIGHTS AND MEASURES

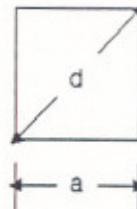
For site inventory or reconnaissance, this section describes quick-and-dirty methods for estimating the physical size of AML sites when in the field with nothing more than the equipment listed in Appendix A. Estimate length with paces and convert to feet or yards as described under Distance in Appendix C. The following methods provide crude estimates of area, volume, and tonnages. These methods are adequate only for preliminary planning, cost estimates, and budgeting. Afterwards, if the site warrants detailed characterization and engineering, revise estimates with professional land surveys.

#### AREA

Match the given area with one of the shapes below. Pace the indicated sides and convert into length with preceding unit pace length. Substitute lengths into given formula and calculate area. For a complex area, subdivide into simple shapes given below, calculate area for each shape, and add areas for a total area.

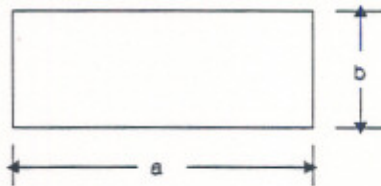
Square:

$$\text{Area} = a^2 \text{ or } \text{Area} = 0.5 d^2$$



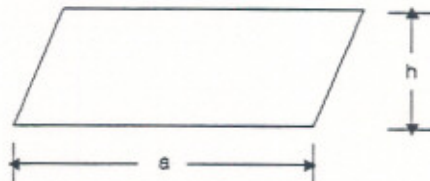
Rectangle:

$$\text{Area} = ab$$



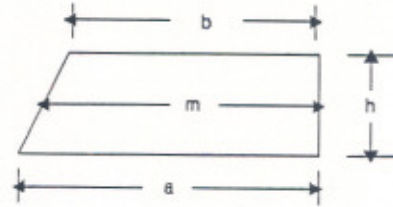
Parallelogram (opposite sides parallel):

$$\text{Area} = ah$$



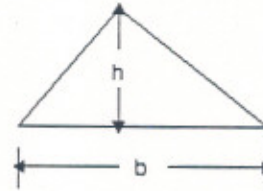
Trapezoid (four sides, two parallel):

$$\text{Area} = 0.5h(a+b) \text{ or } \text{Area} = hm$$



Triangle:

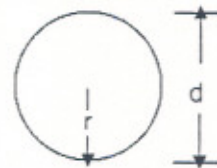
$$\text{Area} = 0.5bh$$



Circle:

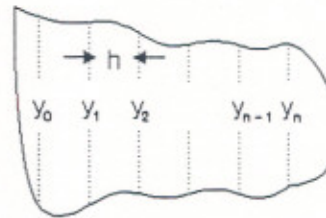
$$\text{Area} = 3.14r^2 \text{ or } \text{Area} = 0.785d^2$$

$$\text{Circumference} = 6.28r \text{ or } = 3.14d$$



Alternative Method For Irregular Shapes

$$\text{Area} = h[.05(Y_0+Y_1)+Y_1+Y_2+Y_3+Y_{n-1}]$$



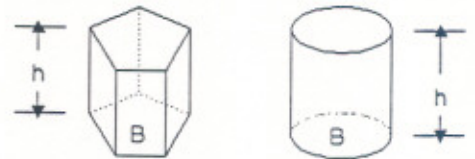
## VOLUME

Match the given volume with one of the shapes below. Pace the indicated sides and convert into length with above unit pace length. Where a formula requires a base area, calculate area with formulas in preceding section. Substitute lengths and base areas into given formula and calculate volume. For a complex volume, subdivide into simple shapes given below, calculate volume for each shape, and add volumes for a total volume.

In the following formulas B is area of base, and h is altitude of the volume. Altitude can be obtained from topographic maps by subtracting contour elevation of the base from contour elevation of the top. Alternatively, pace the side slope, measure its vertical angle with clinometer, and use trigonometry to determine the altitude.

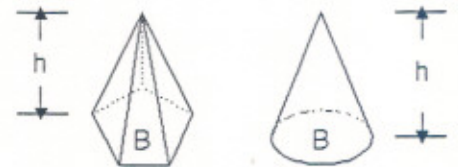
Prism or Cylinder:

Volume =  $Bh$  where  $B$  is area of base.



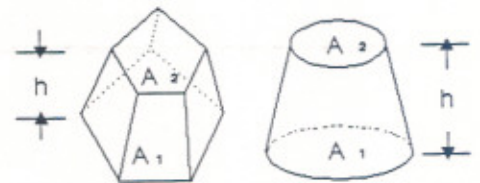
Pyramid or Cone:

Volume =  $0.33Bh$  where  $B$  is area of base.



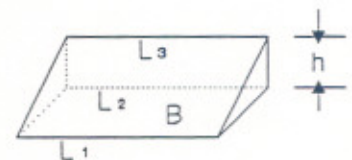
Frustum of Pyramid or Cone:

Volume =  $0.33[A_1 + A_2 + (A_1 A_2)^{0.5}]h$   
where  $A_1$  and  $A_2$  are areas of bases.



Wedge:

Volume =  $0.5Bh((L_1 + L_2 + L_3)/3)$   
where  $B$  is area of base.



### TONNAGE

Select appropriate unit weight from Table D-I. Substitute unit weight and volume in the following formula and calculate tonnage.

Tonnage = \_\_\_\_\_  $\text{yd}^3$  x \_\_\_\_\_  $\text{tons/yd}^3$



TABLE D-I  
WEIGHT OF MATERIALS\*

| Material               | Loose<br>tons/cu yd | Bank**<br>tons/cu yd |
|------------------------|---------------------|----------------------|
| Basalt                 | 1.65                | 2.50                 |
| Bauxite, Kaolin        | 1.20                | 1.60                 |
| Caliche                | 1.05                | 1.90                 |
| Carnotite, Uranium Ore | 1.38                | 1.85                 |
| Cinders                | 0.48                | 0.73                 |
| Clay-Natural Bed       | 1.40                | 1.70                 |
| Dry                    | 1.25                | 1.55                 |
| Wet                    | 1.40                | 1.75                 |
| Clay & Gravel-Dry      | 1.20                | 1.40                 |
| Wet                    | 1.30                | 1.55                 |
| Coal-Anthracite, Raw   | 1.00                | 1.35                 |
| Washed                 | 0.93                |                      |
| Ash, Bituminous Coal   | 0.45-0.55           | 0.50-0.75            |
| Bituminous, Raw        | 0.80                | 1.08                 |
| Washed                 | 0.70                |                      |
| Decomposed Rock-       |                     |                      |
| 75% Rock, 25% Earth    | 1.65                | 2.35                 |
| 50% Rock, 50% Earth    | 1.45                | 1.93                 |
| 25% Rock, 75% Earth    | 1.33                | 1.65                 |
| Earth-Dry Packed       | 1.28                | 1.60                 |
| Wet Excavated          | 1.35                | 1.70                 |
| Loam                   | 1.05                | 1.30                 |
| Granite-Broken         | 1.40                | 2.30                 |
| Gravel-Pitrun          | 1.63                | 1.83                 |
| Dry                    | 1.28                | 1.43                 |
| Dry, 1/4-2 in.         | 1.43                | 1.60                 |
| Wet, 1/4-2 in.         | 1.70                | 1.90                 |
| Gypsum-Broken          | 1.53                | 2.68                 |
| Crushed                | 1.35                | 2.35                 |
| Hematite, Iron Ore     | 2.00-2.70           | 2.35-3.20            |
| Limestone-Broken       | 1.30                | 2.20                 |
| Crushed                | 1.30                | -                    |
| Magnetite, Iron Ore    | 2.35                | 2.75                 |
| Pyrite, Iron Ore       | 2.18                | 2.55                 |
| Sand-Dry, Loose        | 1.20                | 1.35                 |
| Damp                   | 1.43                | 1.60                 |
| Wet                    | 1.55                | 1.75                 |
| Sand & Clay-Loose      | 1.35                | 1.70                 |
| Compacted              | 2.03                | -                    |
| Sand & Gravel-Dry      | 1.45                | 1.63                 |
| Wet                    | 1.70                | 1.88                 |
| Sandstone              | 1.28                | 2.13                 |
| Shale                  | 1.05                | 1.40                 |
| Slag-Broken            | 1.48                | 2.48                 |
| Snow-Dry               | 0.11                | -                    |
| Wet                    | 0.43                | -                    |
| Stone-Crushed          | 1.35                | 2.25                 |
| Taconite, Iron Ore     | 1.80-2.10           | 2.60-3.05            |
| Top Soil               | 0.80                | 1.15                 |
| Tap Rock               | 1.48                | 2.20                 |

\*Varies with moisture, grain size, compaction, etc. Perform tests to determine exact material weights.

\*\*Bank: quantity of an excavation measured in place before being disturbed.

REF: Caterpillar Performance Handbook, Peoria IL, Oct. 1989, ed. 20, p. 888.